CURTIS POND WATERSHED SURVEY

FALL 2003

Conducted by volunteers under the guidance of
the Lakes and Ponds Working Group of The Calais Conservation Commission and
the VT Department of Environmental Conservation, Lakes and Ponds Section

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INTRODUCTION

The Curtis Pond Watershed Survey is a portion of the larger effort to survey all of the lakes and ponds located in Calais. It was conducted during the summers of 2001, 2002 and 2003 under the guidelines developed by the Vermont Agency of Natural Resources. Susan Warren from the Lakes and Ponds Section of the Agency provided two training sessions in May and July of 2001 and led the watershed walk in September of 2003. This is an all-volunteer effort that has been supported by residents of Calais. The survey is a work-in-progress. This document is a summary of what the volunteers have observed to date and recommendations that arise from these observations. Because of variable weather conditions and changes evolving in the watershed, it is recognized that the survey is a snap shot in time, which will benefit greatly from continued observations. The report has been approved by the Calais Conservation Commission.

RECENT HISTORY PRECEDING THE WATERSHED SURVEY

In the summer of 2000 two conditions existed that potentially indicated a decline in water quality at Curtis Pond and raised significant concern amongst the users of the pond. Tests for bacteria at the Town's swimming beach produced results that indicated it was unsafe to swim. Subsequently, the bacteria decreased to acceptable levels, but concern remained. Secondly, an unprecedented algae bloom of large mats of green floating algae and brown worm-like algae occurred and persisted for most of the summer. In addition to these events, data collected under the Vermont Lay Monitoring Program indicates an increase in nutrient levels in the water from 1998 to the present. Responding to citizen concerns, the Calais Conservation Commission initiated a study of all of the lakes and ponds in the town. Thanks to a strong group of interested volunteers, a great deal has been learned about the conditions and health of Curtis Pond.

SURVEY GOALS

The first goal of the watershed survey is to develop an understanding of the health of Curtis Pond and establish a baseline against which future changes can be compared. The survey looks to answer two questions. How are the activities, conditions and land uses in the watershed affecting the water quality? Is it safe to swim in the pond?

The second goal of this survey is to share our findings with as many members of the community as possible. Through these efforts we hope to educate all users-swimmers, boaters, fishermen, residents- about the current health of the pond; to inform them of any conditions which may be adversely affecting water quality and provide recommendations for improvement; and to foster cooperative and productive working relationships.

SURVEY METHODS with Background Information

How are Activities, Conditions & Land Uses in the Watershed Affecting Water Quality?

To address the question of water quality this survey is using the methods described in "Citizen Lake and Watershed Survey Instructions" developed by Vt. Agency of Environmental Conservation (VTDEC). As defined by these instructions, "A lake watershed, also called a drainage basin, consists of all the land area which surrounds and drains into a lake. Watersheds include the land uses and natural habitat around a lake as well as the ground water, springs, streams, rivers and wetlands which feed into the lake."

Further, "All activities which occur in a lake's watershed can affect lake water quality. Sediment and nutrient runoff from the surrounding land causes nutrient enrichment of lakes and results in a variety of water quality problems. Excessive algal growth decreases water clarity and in some cases causes unsightly surface scums and foul odors. Excessive aquatic plant growth can interfere with boating, swimming, fishing and other recreational activities. As these plants and algae die back each year they fall to the lake bottom, causing sediments to build up more rapidly. As they decompose, oxygen is used and may become limiting for certain species of fish. The alteration of the natural environment also causes other changes in fish and wildlife habitat.

Nutrients are introduced into a lake both naturally and as a consequence of human activity along the lakeshore and in the drainage basin. While the natural addition of nutrients occurs slowly over time, cultural additions of nutrients can occur at an accelerated pace. Most water quality problems in Vermont lakes and ponds are the result of land runoff as opposed to discharges from industries or treatment plants. Watershed sources of pollution include failing septic systems, shoreline erosion, fertilizer runoff, agricultural and urban runoff, erosion from logging or construction operations, and gravel road and streambank erosion."

The nutrient of greatest concern is phosphorus. It is the nutrient in shortest supply in Vermont lakes. Without this nutrient plant growth cannot be sustained. Increases in phosphorus, even relatively small amounts, stimulate increased plant and algae growth. Hence, it is the best nutrient to measure to track changes in enrichment.

The "Citizen Lake and Watershed Survey Instructions" guide volunteer participants to observe conditions and evidence of activities in the watershed that are affecting the water quality of a lake or pond. These observations are laid out in three sections and reported accordingly.

Section 1: The **In-lake Observations** map conditions within the water body.
Section 2: The **Shoreland Observations** map land use and conditions along the water's edge.
Section 3: The **Watershed Observations** map land use and conditions along streams and roads

This water quality method is a subjective look at the health of the pond. The survey does not attempt to collect quantitative data on nutrient enrichment as it currently exists in the pond. However, there is a parallel effort, the Vermont Lay Monitoring Program, which was created by the state and provides this information. Under this program volunteers periodically collect water samples which are analyzed by VT Agency of Natural Resources (ANR) and an annual report is distributed with all the nutrient data

– new and historical – for each participating lake. Curtis Pond has been part of the Lay Monitoring Program since 1994. Knowing the nutrient levels contributes to a fuller understanding of water quality. Therefore, a summary of the findings obtained through the Lay Monitoring Program is included under the **In-lake Observations.**

Is It Safe to Swim in Curtis Pond?

To address the question of whether swimmers can feel safe to swim without risking illness, a program to measure the presence of the bacterium *Eschericha coli* (commonly called just *E. coli*) was created. *E. coli* is a common (and necessary) intestinal resident in both people and animals. Measuring *E. coli* in open water helps determine the level of fecal contamination at a particular time, and the possibility that other organisms harmful to health (but harder to measure than *E. coli*) are also present. Volunteers periodically collect samples at six different locations in the pond and have these samples tested by VT Department of Water Quality. The results of these tests are compared to safe swimming standards set by the State of Vermont. In this report the results of *E. coli* measurements are provided as part of **In-lake Observations.**

Section 1: IN-LAKE OBSERVATIONS

Curtis Pond is a small, warm water lake. It has a surface area of 72 acres. The maximum depth is 31FT (9.4M). The average depth is 11FT (3.4M). The area of the watershed is 917 acres, which is also relatively small. All of the water sources are local flowing from lands immediately surrounding the pond. The Curtis Pond watershed is a headwaters, a place where streams and rivers originate. The outflow from the pond feeds a tributary of the Pekin Brook.

Nutrient Data from the Lay Monitoring Program

Water quality data has been collected at Curtis Pond for nine years by volunteers working as part of the Lay Monitoring Program. Many thanks go to Mac and Lucille MacLellan, Doug and Andrea Braasch.

Compared to other Vermont lakes, the data taken for Curtis Pond in the summer of 2002 indicates:

Water clarity – moderate
Algal population density – moderate
Nutrient enrichment – high

Over the period from 1994 to 2002 water clarity averaged 13.8FT (4.2M). From year to year the clarity has varied by more than 3FT, but no trend of either increasing or decreasing clarity has been shown. Algal population density is determined by measuring the amount of chlorophyll-a in the water. Nutrient enrichment is found by measuring the amount of phosphorus in the water. Both of these indicators experienced a marked increase in 1998 and have continued at elevated levels to the present. As compared to readings prior to 1998, chlorophyll-a is up 67% and phosphorus is up 57%. (See Appendix A). These trends indicate that the pond is seeing an acceleration of the aging process, known as eutrophication. If these trends continue more widespread algae

blooms and denser aquatic plant growth can be expected. These large changes over a short time raise the following questions: What are the sources of enrichment? Are human activities a significant factor? Can the trends be slowed or reversed?

Field Observations from this Watershed Survey

Summary in-lake observations are listed below. Three maps follow. They show the distribution and density of aquatic plants (MAP 1), the bottom composition of the pond (MAP 2) and a topographical display of the depths of the water (MAP 3). It is noted that the patterns of algae shown on the first map represent the findings from summer 2001. The distribution of algae changed markedly in 2002 and 2003, so it was not feasible to include the new patterns on the map. In Appendix B, detailed observations are presented for waters in front of each parcel of land including a photograph of the house or camp.

Aquatic Plants:

- The density of plants correlates directly with the depth of the water. In all of the shallow portions of the pond (depth of 5ft or less), there are high densities of submerged and floating-leaf plants. These areas include the portion of the southern shore close to the Worcester Road, the cove near the dam, the cove west of the "Island", the wide area north of the Narrows and the northern end of the pond.

- Curtis Pond has a wide diversity of aquatic plants, including a number of rare ones. Vermont state scientists have identified four rare species, including one that is globally very rare. They are:

White water-crowfoot (*Ranunculus longirostris*) – rare to uncommon
Ogden's pondweed (*Potamogeton ogenii*) – globally very rare
Prickly hornwort (*Ceratophyllum echinatum*) – very rare
Straight pondweed (*Potamogeton strictifolius*) - rare

- There are dense growths of cattails at the southern inlet near the State Fishing Access, at the northwestern inlet near the beaver dams and along the northern shore.

- No exotic, invasive aquatic plants (e.g. eurasian watermilfoil) or fauna (e.g. zebra mussels) have been observed to date.

- Algae:

Summer 2001-Far less algae was observed in the summer of 2001 compared to summer of 2000. Weather patterns were also markedly different in those two years. Summer 2000 was unusually wet and cool. Summer 2001 had near record dryness and heat. In September isolated mats of floating green algae (see map) were found in the shallow areas of the pond. These mats varied in size from 1-2ft to 15-20ft. A thick brown cover was found on the pond bottom in the water off the portion of the southern shore close to the Worcester Road. It is believed to be a form of algae.

Summer 2002 – The character and, perhaps, the species of algae found in summer 2002 were significantly different from 2001 observations. The number of mats of floating green algae was markedly less. In 2002 mats were only found in the southern portion of the pond along the Worcester Road and in the cove near the dam. The areas around the "Island", in the narrows, and in the north, where there had been significant mats in 2001, did not have floating green algae in 2002. However, significant amounts of submerged, dark green algae were found attached to underwater plants. At its densest, the algae so completely covered plants that they were nearly unrecognizable. In the water just north

of the narrows on both east and west sides of the pond, the algae-covered plants looked like colonies of stalagmites. Also, this algae was observed as small dark green globs floating on the surface of the water. These were common all over the pond. Small amounts of other algae were found on the bottom, including one brown mat and several medium or dark green puffballs.

Summer 2003 – Again the character and location of algae was significantly different from observations made in 2001 and 2002. The southern portion of the pond south of the narrows had almost no floating mats of algae and the amount of bottom algae clinging to aquatic plants was less. In the early summer there was some floating pinkish-brown worm-like algal growths. However, in the northern shallow portion of the pond there were dense mats of floating algae present for most of the summer. These mats only dissipated towards the end of September. Most of the aquatic plants north of the narrows developed an ever-increasing coverage of dark green bottom algae. By the end of the summer the coverage was so heavy that the plants became unrecognizable. Clumps of this algae and its host plants were seen frequently floating on the surface. In the north none of the worm-like algae was present.

- Waterweed (*Elodea canadensis*) is a native aquatic plant that thrives in ponds with high nutrients. Even though there have been only three years of observations, the amount of waterweed has increased significantly. Old patches have grown bigger and denser. New sprigs were seen in areas, such as along the western shore, where waterweed was not previously present. The increased occurrence of waterweed correlates with the increased levels of nutrients in the pond recorded by the Lay Monitoring Program.

- Water lilies (*Nymphaea odorata*) are another native plant common to ponds in Vermont. This plant, like waterweed, is expanding in Curtis Pond. Many new clumps are present along the western shore. In interviews with long-time residents of the pond, many remembered the time, when most of the shore was free of water lilies. Now it is more common to see water lilies than open water at the shoreline.

- Where the shoreline is shaded by forest, aquatic plants are absent or minimal in the first 10-15ft from shore. A good buffer of native plants helps suppress the growth of aquatic plants.

Odors, Oily Sheen, Foam or Turbidity:

-None of these were detected, except for small amounts of natural oil sheen resulting from decomposition of dead plant matter in the shallow areas where high densities of submerged plants exist.

Inlet Conditions:

The pond bottom is shallow at all four inlets (two in the south located on either side of the launching beach at the VT State Fishing Access and two in the north located at the beaver dam and at the eastern wetlands), but there is no evidence of deltas having been created by erosion along the inlets upstream of the pond.

Bottom Composition:

- Wherever the pond is shallow the bottom is silt and organic muck. Along the undeveloped shoreline there is a layer of fallen trees, branches and leaves (i.e. detritus) on top of the muck. Where the pond gets deeper more quickly the bottom composition is typically gravel or cobble interspersed with a few larger boulders.

- In the water near lot 40 large areas of the bottom are covered with submerged plastic or rubber sheeting, which is in place in an attempt to suppress growth of submerged aquatic plants. Observations from the summer of 2003 indicate that the sheeting is not effective. Water lilies and submerged aquatic plants are growing on top of the sheeting.

Fishing:

- Fishing is described as good. Many visitors put in boats at the State Access to go fishing.

Swimming:

- Swimming conditions are good in front of more than half of the dwellings (~60%) and impaired in front of the remainder due primarily to shallow, silty conditions and heavy plant growth.

Wildlife:

- There is an abundance of wildlife in and around the pond. Mussels are plentiful throughout the pond in colonies along the shore. Frogs are heard throughout the spring and summer. Several families of otters live near and feed in the pond. Beavers have made dams near the northwestern inlet and at a couple other locations. Numerous families of mallards live and breed on the pond. One or two families of geese raise young on the pond and depart in early August. There are kingbirds, blue heron, red-tailed hawks, hummingbirds, red-wing blackbirds and a wide range of song birds which nest about the pond. Moose have been seen feeding in the shallows at the northern end of the pond. Deer are spotted frequently on the western shore. Coyotes have been heard howling on summer evenings. Small carnivores, fox and fisher cats, have been tracked in the woods. Evidence of black bears has been found in berry patches.

Swimming Safety – Observations of *E-coli* bacteria

The goal of the Curtis Pond volunteers was to gain a better understanding of the swimming safety throughout the pond by increasing the number of locations and the frequency of testing for *E. coli* bacteria. Normally, the town's health officer and swim program organizers have collected samples at the Town Swimming Beach prior to the swim instruction season. On a few occasions further testing was warranted because of a high test result. This was the case following a test conducted in June of 2000, which raised concerns about Curtis Pond water quality. Swim program organizers increased testing at the swim area in each of 2001 and 2002. Tests were performed about every 10 days for the duration of instruction and results were all well below State defined limits. At the same time, the Curtis Pond volunteers initiated their plan to assess the whole pond. The program began in August 2001 and was continued through September 2003.

The plan calls for taking water samples at six locations in the pond every two weeks during the summer. *E. coli* are very small and it is necessary to let them grow into visible colonies under laboratory conditions in order to count them. To do this, the water samples are brought to the Vermont State Department of Water Quality.

Obtaining a count is one thing; associating counts with health risk is more difficult. The standard in current use by the State Water Resources Board advises that waters producing less than 77 colonies per 100 milliliters of water are safe for "contact recreation" such as swimming. All Calais waters (Class B waters) are expected to meet this criterion. At this threshold there is a risk of 4 gastrointestinal illnesses per 1,000 swimming events.

The results of the testing thus far show that *E. coli* levels in Curtis Pond are very low and swimming is safe (See MAP 4). The average result for the pond was 4.3 bacteria colonies/100 ml. Only one sample, taken from the cove near the dam, exceeded the state standard of 77. It is noted that there are two areas of the pond where the *E. coli* levels were somewhat higher than the rest of the pond. These areas are the cove near the dam (Location 6), which averaged 10.6, excluding the single high result of 89, and the shallow area of the pond just north of the narrows (Location 4), which averaged 6.2. These are still low numbers. The rest of the pond averaged 2.3 colonies of *E. coli*/100 ml. It is interesting to observe that the presence of *E-coli* in 2003 was lower than the previous two years. For 2001 and 2002 the pond average was 5.6 colonies/100ml. For 2003 the pond average was 2.4 colonies/ml. Further observations are needed to determine if this is a trend or just a temporary decrease.

We are very appreciative of the help provided by Jerry Divincenzo, Head of the Environmental Lab in the Department of Water Quality, who has guided our efforts and overseen the state testing. This has been a great learning experience and one that we hope to continue into the future.

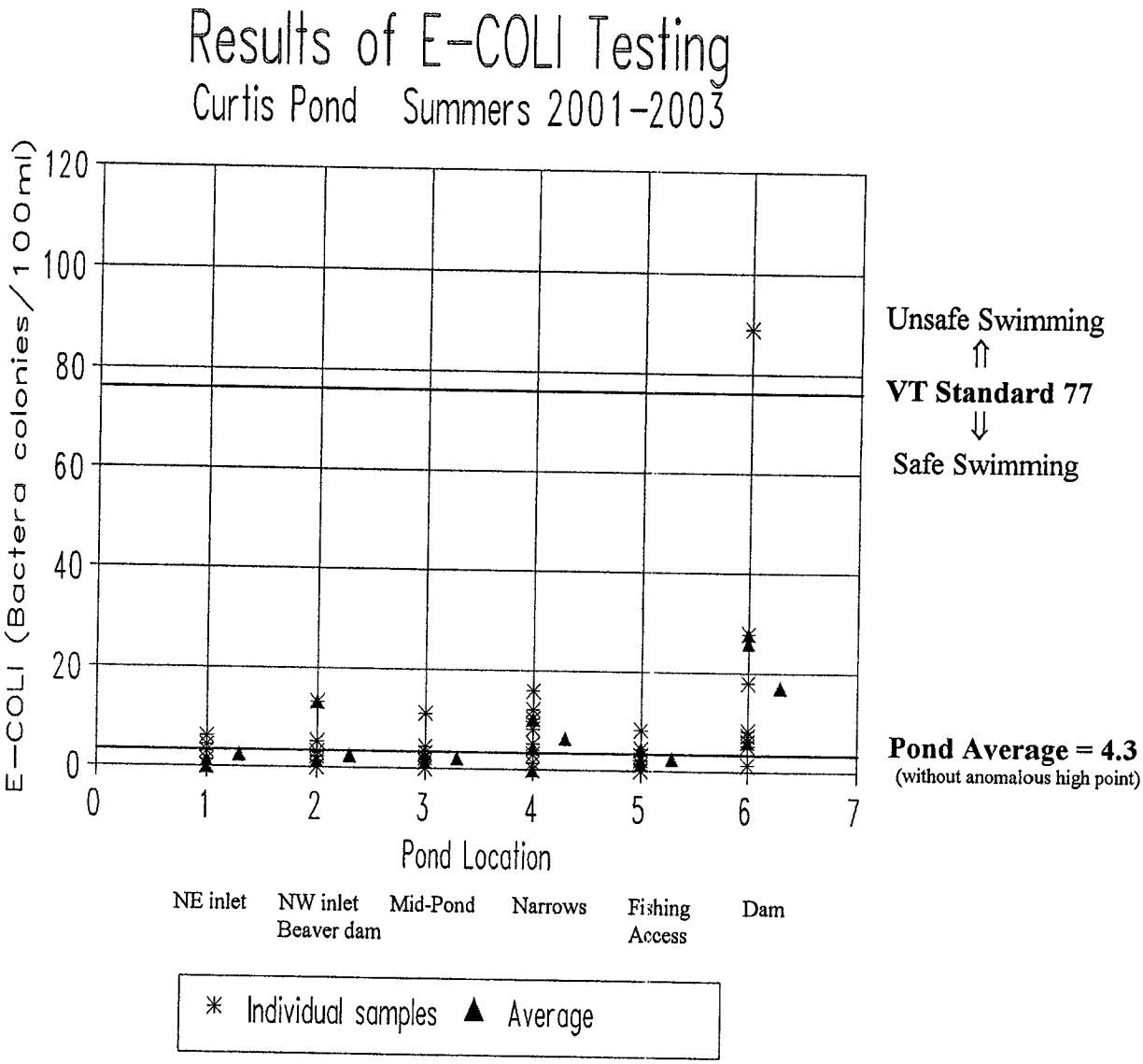
Section 2: SHORELAND OBSERVATIONS

Curtis Pond has approximately 3 miles of shoreline. More than two-thirds of the shoreline (~70% or ~2 miles) is undeveloped woodlands and wetlands. The remaining shoreline (~30%) is a mixture of woody buffers and lawns.

Most of the shoreland is privately owned (84%). It is divided into 52 parcels containing one dwelling each. Five of these parcels have substantial acreage. The houses on these parcels are more than 500FT from shore. The remaining 47 parcels have dwellings less than 150FT from shore. At the time of this report, 17 of the 52 dwellings are year-round houses; 12 of these are located near the shoreline.

The balance of the shoreland (16%) is publicly held. There are three public parcels – the "Island", the Town Swimming Beach, and the VT State Fishing Access.

Summary observations are listed below. A map follows which shows the composition of the shoreline and the relative amounts of natural buffer (i.e. woods,


Results of E-COLI Testing
Curtis Pond Summers 2001-2003
E-COLI (Bactera colonies/100ml)
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
Pond Location
NE inlet
NW inlet
Beaver dam
Mid-Pond
Narrows
Fishing
Access
Dam
Unsafe Swimming
⇑
VT Standard 77
⇓
Safe Swimming
Pond Average = 4.3
(without anomalous high point)
* Individual samples ▲ Average

MAP 4

shrubs and wetlands) versus cleared areas (i.e. lawns and beaches) (MAP 5). Appendix C provides detailed observations for each of the parcels including a photograph of the shoreline taken in summer 2003. It is hoped that these will be a useful historical reference for the future.

Woodland, Shrub and Wetland Buffers:

-Vegetative buffer strips between developed areas and surface water are the single most effective tool to protect water quality. Overland runoff, carrying sediments and nutrients, flowing through a vegetated area is filtered and absorbed by the duff layer and the plants.

- As stated earlier, 70% of the shoreline is undeveloped. Nearly all of the western and northern shorelines are undeveloped. They account for ~49% of the shoreline. Large stands of woods and wetlands make up the preponderance of the land at the Town Swimming Access and the VT State Fishing Access (~8% of the shoreline). The rest of the shoreline is privately owned and divided into lots for camps and houses. Many of these lots have large areas of undeveloped woods and wetlands. Even the smaller lots typically have a barrier of woods that separates them from their neighbors. In total, there are approximately 2000FT (~13% of the shoreline) of undeveloped lands within the residential properties.

- Narrower buffers are present on some of the properties. A woody/shrubby buffer of 10 – 50ft exists for approximately 500FT (3%) of the shoreline. Most of this buffer is less than 25ft deep. Approximately 1600FT (11%) of shoreline have a buffer of less than 10ft.

Cleared Shoreline:

Cleared shorelines are those areas where lawn or beaches are located at the water's edge. Nearly all of the shoreline in this category is lawn. There are very few sand or gravel beaches on Curtis Pond. Grasses abut the edge of the pond for approximately 2400FT (16%) of shoreline. About two-thirds of the grassed areas have canopies of mature trees, which improve the filtration of runoff flowing through these lawns and provide a better buffer than open lawns.

Location of Dwellings:

-Of the 52 dwellings located on properties with shoreline, 5 are located more than 500FT from shore and 8 are between 100 and 500FT from the shore. The other 39 sit close to the shore at an average distance of 25FT.

Exotic, Invasive Plants:

- Small patches of purple loosestrife (*Lythrum salicaria*)are scattered about the shoreline.

- Two small patches of common weed (*Phragmites australis*) were found. One is along the shoreline of Lot 16. Its removal was effected in the summer of 2002. The other is located in the cove near the dam at Lot 4-021. In September 2003 large portions of this patch were removed. A follow-up effort is needed to complete the job.

- Both of these plants are highly invasive and destructive to native plants.

Erosion:

- Because most of the observations of the shoreland were made in the summer when the weather was dry, the impact of heavy rains and identification of points of heavy run-off were not observed. However, there is no evidence of long term erosion, such as exposed soil banks and eroded gullies along the shoreline. There are a couple small paths used by swimmers. Since 2001 significant clearing of trees and shrubs was performed prior to new construction at a couple of camps. During the time that these sites were bare of vegetation, soil eroded and added unnecessary nutrients to the pond. In 2002 and 2003 a few camps dumped gravel into the water to create beaches, which added more undesirable nutrients into the pond.

- Curtis Pond is fortunate to have a minimal amount of graded/maintained roads close to the shoreline. The Worcester Road is the only one and it follows the shoreline closely for less than 10% of the total. The camp roads are minimally maintained and have not been graded for at least the last ten years and perhaps much longer. The lack of graded/maintained roads means that nutrients from gravel and soil that might enter the pond through run-off are significantly lower at Curtis Pond than at other ponds in the region. Still erosion from the Worcester Road, which has occurred over many years, has had a marked impact on the southern end of the pond. The water level is shallower and there is a dense coverage of cattails and water lilies. More information on erosion along the roads is presented as part of the **Watershed Observations**.

Septic Systems:

- A failing or sub-standard septic system can be a source of both pathogens and nutrients to the lake. It is not known how many of the existing dwellings have septic systems built to minimum state health standards. However, conversations with residents indicate that numerous shoreline residents have been required to up-grade their septic systems when they applied for building permits.

Section 3: WATERSHED OBSERVATIONS

The watershed of Curtis Pond is relatively small. It is composed of 917 acres. No large streams or rivers flow into the pond. Water comes from runoff of rain and snowmelt, springs, seasonal streams and two small brooks that flow year round. Both of these brooks originate in the high wetlands located at the western edge of the watershed. One flows southward, turns east and follows the Worcester Road down hill emptying into the pond just north of the Vermont State Fishing Access. The other brook flows northward, turns eastward down the hill and reaches the pond at the beaver dam in the northwest corner of the pond. The attached watershed map shows the location of these brooks and the wetlands where seasonal streams occur.

The survey instructions, provided by the Vermont Agency of Environmental Conservation, identify the following areas and reasons for collecting information.

Streams are observed to determine average flow, odors indicative of pollution (e.g. sewage or manure), oily sheens, foam and turbidity. Of the above conditions, turbidity is the most likely indication of pollution problems as it results from cleared land and erosion. Under natural conditions (forested land, no development) streams will flow mostly clear even in heavy rains. The presence of algae is noted. It's an indicator of nutrient loading to the water and/or loss of stream-side buffering vegetation, which filters and purifies runoff from uphill land uses. Protection or reestablishment of tributary buffers is an important element in protecting the water quality of a lake.

Roads and ditches, gravel or paved, can be a significant source of sediment to waters if not properly constructed and maintained. Sedimentation is the greatest cause of pollution of streams in Vermont, and can be a significant source of phosphorus to lakes. Observations are made of road drainage structures and their success or failure in managing runoff. Erosion of side ditches, road surface and areas around culverts and bridges are evaluated.

A watershed walk was conducted on 18 September 2003. Its purpose was to gather information on activities within the watershed that may be affecting water quality. The group, who conducted the survey, walked to various locations in the watershed to make observations along the streams and roads. The group was composed of Susan Warren from the Water Quality Division of the Vermont Agency of Natural Resources, Doug and Andrea Braasch, Lois Bradt, Ilona Lind, Galen Whittaker and Noreen Bryan. Most of the effort was directed to areas along the Worcester Road, County Road and Random Road. This was not an exhaustive survey, but provides the basis for some conclusions and recommendations for improvements and future investigations.

Land Use in the Watershed:

The land use within the Curtis Pond watershed is primarily residential and undeveloped wetlands and forests. On the shoreline of the pond is a mix of summer camps and year-round houses. Agricultural uses are limited. There is one hay and corn field along the Worcester Road across from the Town Swimming Beach. There are two small herds (~5 – 20 head) of cattle and/or sheep. One is located to the south of the pond on land without shoreline which has pastures located >1000FT from shore; the other is located to the north on property with >500FT of shoreline. It is not known how close the pasture comes to the shore.

Specific observations follow. The numbers below correspond to locations shown on the watershed map (MAP 6).

Worcester Road – Town Swimming Access to Collar Hill Road

Location 1 - The Culvert under the Worcester Road between the Hay Field (south) and the Macke Property, Parcel 42 (north). Coming down hill from the east,

runoff from the road flows directly into the culvert and has deposited lots of gravel and sediment into the ditch. The culvert inlet on the south side of the road is nearly completely filled in. Runoff carrying liquid manure, used to fertilize the hay field in the spring, flows through a narrow woody buffer into the culvert. This is of concern because the road is within 50 feet of the pond at this location.

Grading the road to create even, sheet flow into the grassy ditches would reduce sediments reaching the pond. The nutrient supply to the pond from the manure can be reduced by creating a larger buffer or by using less manure on the slope near the culvert.

Location 2 - Culvert between the Southern Wetlands and the Vermont State Fishing Access. At the inlet on the southern side of the road a moderately steep bank leads to the culvert, which is surrounded by clumps of loose soil. The bank is soft and unstable. Scum on the pooled water about the culvert is probably caused by runoff from the road. At the outlet across the road there is some undercutting of the bank, but no evidence of an open channel flowing into the pond. It appears that the marsh is acting as a good filter for sediment and gravel.
Both sides of the road need rock headers. A filter fabric over the inlet of the culvert is needed.

Location 3 - Justa Road. The brook coming down hill along the Worcester Road turns north and flows in a ditch beside Justa Road. There are two culverts where the stream crosses under Justa Road and flows through marsh into the pond. In the culvert nearest Worcester Road there are small amounts of gravel from the road. Throughout the stream there is iron bacteria slime. The Worcester Road edge from Justa Road to the Rays' driveway would benefit from grading to distribute the runoff from the road evenly into the field and, thereby, eliminate the channelized flow into the stream.

Locations 4,5 & 6 - Steep Hill Ascending Worcester Road from the Rays' Drive to Robinson Hill Road. Runoff from the road has created deep gullies on both sides of the road, but particularly on the pond side. At the culverts under the Worcester Road there is severe erosion and large, widely distributed deposits of sediment and gravel. The banks of the stream, which flows parallel to the road, are undercut and have deposits of gravel from the road. At site #6, a turn-out was created with the result that gravel and sediment from the road flow directly into the stream. **The culvert inlets and outlets (under driveways and under road) need rock headers. Rock-lined swales are needed in the steepest portions of the road to prevent erosion into the stream.**

Location 7 - Intersection of Robinson Hill Road and Worcester Road. A small stagnant pool is located on the uphill side. Sedges and a young plant of cattails are growing in the pool.

Location 8 - Wetlands Located Near the Top of the Watershed. The two year-round brooks, which supply waters to the pond, originate in these wetlands. Water from the wetlands to the south flow through a culvert under the Worcester Road into the wetlands to the north. Iron bacteria slime is present near the culvert. A wash-out on the

south side of the road just west of the wetlands appears to fan out into the edge of the wetlands. Sediment and gravel from the road do not appear to be filling in the wetlands.

County Road – Upper Curtis Pond Road to Random Road

Location 9 - Wetlands at Parcels 4-051 and 4-054. The culverts were located and appeared clear. There was no ready evidence of water flowing in channel through the wetlands into the pond. But the weather was dry prior to the watershed walk. This combined with the small herd of cattle which graze in the wetlands may mask the presence of channels. **Further examination of this area during wet conditions would be useful to determine if there is any direct flow of nutrients into the pond.**

Location 10 - Driveway at Posting Sign. There is erosion of the ditch on both sides of the driveway. **Bank stabilization and/or grading of the road to fan out runoff are needed.**

Location 11 - Ascending Section of Road from Gallagher Property (4-055) to Random Road. Erosion has caused a deep gulley on the west side of the road. Thick gravel and sediment have been deposited into the neighboring woodland. **A rock-lined swale is needed to curtail further erosion.**

Random Road – This road climbs westward up from County Road.

Location 12 - Western Portion of Random Road. There are no culverts under the road, so gullies have been created where water moves from north to south across the road. However, the woodlands do not appear to be filling in with gravel and sediment.

Location 13 - Intersection of Random Road and County Road. On the down hill just before the intersection, there are deep, heavily eroded ditches, where flowing water carries gravel and sediment into the ditch along County Road. **A rock-lined swale is needed to curtail further erosion.**

SUMMARY OBSERVATIONS

- Curtis Pond, like any shallow, warm-water lake with relatively high nutrient levels and moderate algae populations, is on the brink of change. If the high levels of nutrient additions continue at today's levels, or worse yet, increase, then reduced clarity and more wide spread, larger mats of algae are the probable outcomes. The increased density of plant matter would use more oxygen and reduce the amount available to fish and other creatures who reside in the pond. Overall, Curtis Pond would become less attractive for swimming, boating, fishing, and as a place to live. From an ecological

point of view, the pond would be accelerated along the path to becoming a marsh rather than a lake.

- Curtis Pond is very fortunate to be a headwaters. There are no streams or rivers that bring nutrients and silt from a long distance into the pond. Further, the pond is fortunate to have only 10% of its shoreline contiguous with a maintained gravel road. However, the gravel roads in the watershed do show evidence of erosion of gravel and nutrients into streams and the pond itself. The rest of the nutrients, which enter the pond, come from many individual sources all along the shoreline. This means that controlling, and perhaps even reducing, nutrients is dependent on the way each resident and user treats his or her portion of the pond, and the way the roads in the watershed are maintained. Some steps that can be taken to reduce nutrient-rich runoff from flowing into the pond follow:

- establish a natural vegetative buffer at the water's edge to replace as much lawn as possible;

- discontinue use of fertilizers and manure on fields, lawns and gardens located within 100ft of shore;

-discontinue using shoreland as pasture;

- prevent clear-cutting along the shore during construction of dwellings;

- improve inadequate or failing septic systems;

- prevent future dumping of sand/gravel into the pond to create beaches;

- continue to maintain private camp roads by adding stone rather than grading and determine which stone has the lowest nutrient content and encourage its use;

- assure that runoff from roads, particularly the Worcester Rd. is minimized; and

- prevent runoff from driveways and drain spouts from creating gullies that feed nutrients directly into the pond.

RECOMMENDATIONS

The sum of the survey observations leads to a group of recommendations, which follow:

-Inform the property owners in the watershed about the ways in which their actions can protect the pond. Distribute a summary of this survey and fact sheets developed by VT Agency of Environmental Conservation (VTDEC), which describe best practices along shorelines and provide information on vegetative buffers and exotic species. It is recommended that this information be provided to all property owners in the watershed immediately. Thereafter, it is recommended that a packet of information be provided to new property owners at the time of purchase. The recommended VTDEC fact sheets are included as Appendix D.

-Distribute throughout the community the information learned about Curtis Pond. Make the fact sheets and the results of the survey available to the citizens of Calais through the Lakes and Ponds Newsletter and by conducting a summer workshop in 2004.

-Continue *E-coli* testing. Apply to VT Agency of Natural Resources for one of their grants awarded for *E-coli* monitoring.

-Encourage re-vegetation of the shoreline.

-Help protect the pond from the introduction of exotic, invasive species that live in the water (e.g. eurasian watermilfoil and zebra mussels) by posting information and procedures for cleaning boats at the State Fishing Access and by establishing a group of volunteers who check the pond for the presence of these species. Consider applying for a grant available from the State for this purpose.

-Remove the small patches of exotic, invasive species located on the shoreline.

-Develop an approach, which is approved by the community, for upgrading failing septic systems.

-Continue to observe algae and determine whether there are increases or decreases in its occurrence.

-Improve the roads in the watershed to minimize erosion and reduce nutrients flowing into the pond. Under the "Vermont Better Backroads Program", the State awards grants to make road improvements, such as rock headers for culverts and rock-lined swales. Apply for grants to make the improvements that are described under **Watershed Observations**.

CURTIS POND

Calais, VT

Lay Monitors: Andrea Triguba Braasch and Doug Braasch

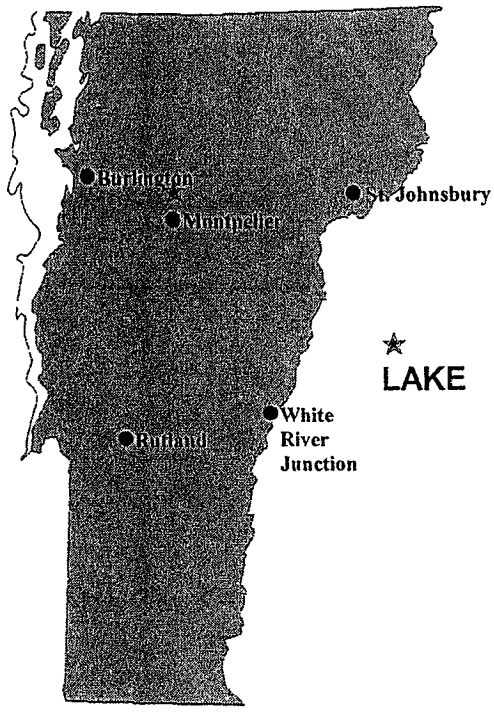
Curtis Pond is a small, warm water lake.

Lake Surface Area:	72	acres	Maximum depth:	31 ft.	(9.4 m)
Drainage Basin Area:	917	acres	Average depth:	11 ft.	(3.4 m)

Compared to other lakes, the 2002 summer means indicate:

Water clarity - moderate
Algal population density - moderate
Nutrient enrichment - high

Trophic State: Eutrophic



APPENDIX A

Curtis Pond

2002 Summary

Parameter	Days	Min	Mean	Max
Secchi (m)	13	3.0	4.1	6.0
Chl-a (ug/l)	13	1.9	6.7	15
Summer TP (ug/l)	13	12	18	26

Annual Data

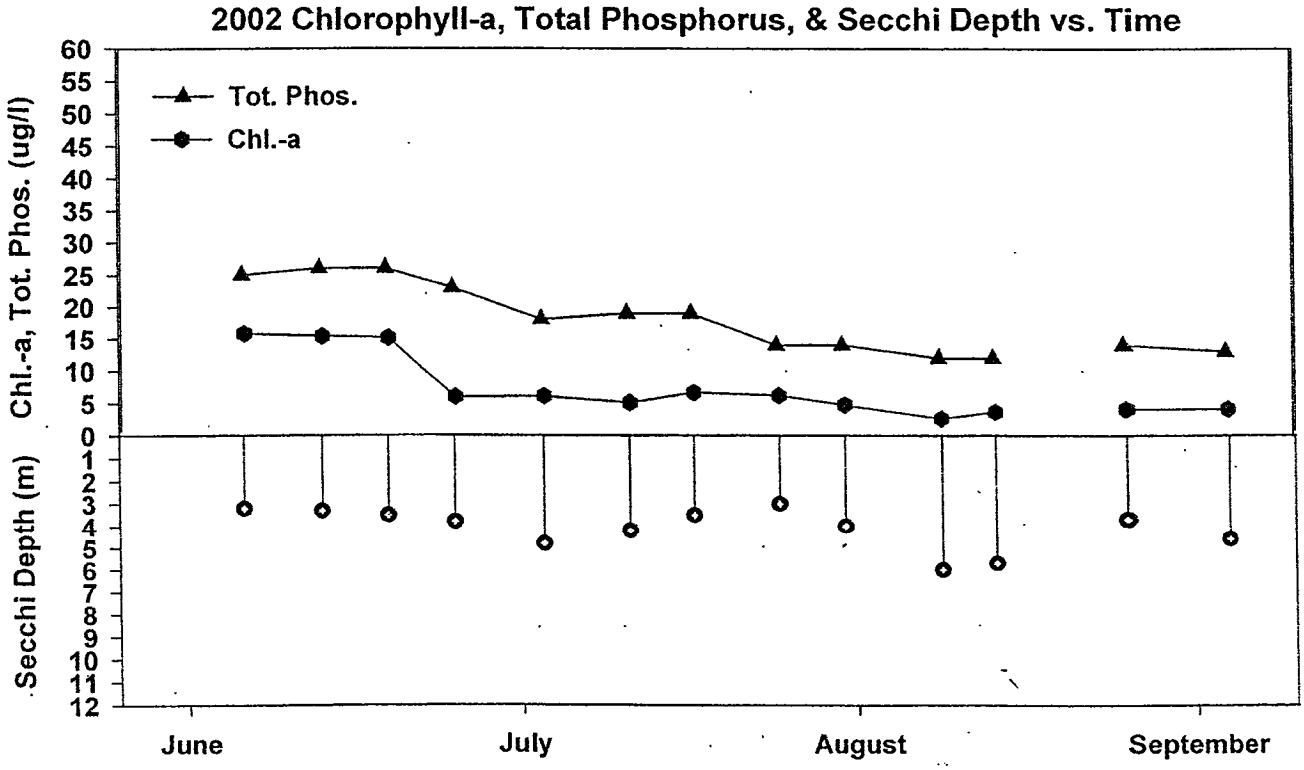
Year	Days Sampled	Secchi (m)	Chloro-a (ug/l)	Summer TP (ug/l)	Spring TP (ug/l)
1994	12	4.0	5.1	12	
1995	10	4.7	4.5	11	18
1996	12	4.6	6.9	12	
1997	12	4.4			
1998	12	3.6	10	19	
1999	10	4.7	11	15	
2000	11	4.3	9.0	18	
2001	14	3.8	9.2	22	24
2002	13	4.1	6.7	18	

5.5 → 9.2 (67% INCREASE)

11.1 → 18.4 (57% INCREASE)

AVG(m) 4.24

AVG(ft) 13.8



Only You...Can Save Your Lake!

The actions of lake and pond shoreland owners are critical to healthy waters. The following is a brief list of how you can save your favorite lake and protect its ecology, health and your enjoyment into the future. "How-to" pamphlets are available on any of the topics below from the Lakes and Ponds Section. For more detailed information contact your lake or pond association or the Lakes and Ponds Section, VT Agency of Natural Resources (802-241-3777) Bldg 10 North, 103 South Main Street, Waterbury, VT 05671-0408.

Please...	How	Why
Go Wild!	• Leave trees and shrubs in a strip up to 100 feet wide along the shore. • Replant native trees and shrubs between your camp and the water. • Reduce lawn size adjacent to the lake. • Don't use fertilizers or pesticides on lawns near the lake. • Instead of repairing or installing a retaining wall, create a vegetated bank.	• Lawns are not effective at erosion control or filtering runoff. • Natural vegetation: ✓ stabilizes the bank; ✓ enhances in-lake habitat; ✓ looks nice from the lake; and ✓ provides shoreland bird and animal homes and food. • Fertilizer and pesticide runoff unnecessarily pollutes the lake with nutrients and toxins.
No Beach is a Good Beach	Don't add sand or other fill to the lake. (Natural beaches are, of course, fine but rare in Vermont!)	Adding sand suffocates the natural bottom habitat, plus can introduce polluting silt to the water. (A permit is required to add fill to a lake, call 802-241-3777 for information.)
Keep Soil on the Ground	Keep land disturbance well back from the water. Surround a work area with a filter screen; mulch, reseed, and replant as soon as possible; and complete work before September 15 (so seed can sprout before winter).	• Eroded soil is the number one pollutant to Vermont lakes and ponds! • Sediment carries the nutrient phosphorus to lakes, causing algae blooms and excessive weed growth. • Turbidity threatens fish and other aquatic life.
Mind your Driveway Manners	Maintain your driveway so that runoff from it cannot reach the lake or pond. • Install waterbars to direct flow into vegetated areas. • Rock-line steep ditches. • Crown it annually. • Relocate it if necessary. Work with your town road commissioner on preventing erosion of town roads.	• Eroded soil is the number one pollutant to Vermont lakes and ponds! • Sediment carries the nutrient phosphorus to lakes. • Turbidity threatens fish and other aquatic life. • Good driveway maintenance saves you money over the long-run.
Don't "Go" in the Lake	• Learn about your septic system. • Conserve water. • Don't add garbage disposals, washing machines or dishwashers unless you're sure your system meets current standards. • Replace systems that don't meet standards. • Pump septic tanks every 3-5 years.	• If any part of your septic system is closer than 50 feet to the lake, or less than 2 feet above the lake level, you could be polluting the lake. • A poor or overloaded system can introduce disease-causing organisms into the lake, resulting in a human health threat and can introduce nutrients into the lake, causing algae blooms and excessive weed growth.
Watch those Ducks	Don't feed waterfowl.	Resident duck and goose populations increase disease causing bacteria in the water, and can increase the incidence of "swimmer's itch." Ducks or geese can even be a significant source of nutrients to lakes or ponds.

APPENDIX D

Please...	How	Why
Be Careful Who You Invite Home	Make sure you aren't transporting organisms from one lake to another. Carefully wash and inspect your boat (and other gear) before moving it to another lake. Learn to identify **Eurasian watermilfoil, water chestnut,** and **zebra and quagga mussels**. Keep a watch out for them in your lake. Plant only native species along the lakeshore. Don't dump bait buckets or aquariums into the lake.	Exotic plant and animal infestations are a serious problem in Vermont lakes, causing significant recreational and ecological damage. Only careful vigilance by all lake users can prevent the spread of harmful exotic species. It is against the law to transport these four species from one surface water to another in Vermont.
Gas and Water Don't Mix	Replace 2-stroke boat engines with 4-stroke or direct-injection 2-stroke engines.	• 2-stroke motors emit 20-30% of the fuel-oil mixture unburned into the lake. • 4-strokes are quieter, use half the gas and have 90% fewer emissions.
Be Kind to Your Neighbors	Protect and support the local wildlife; • stay away from loon and other nest areas; • protect shoreland wetlands; and • enhance your shoreline with native vegetation (see "Go Wild" above).	Lakes are part of the diversity of native habitats in Vermont. Their important role in providing food, shelter and breeding areas for Vermont fish and wildlife cannot be overstated.
Get the Lead Out	Switch from lead sinkers to those made from steel or other materials.	Lead sinkers lost in the lake are often mistakenly eaten by fish or water fowl. In 1998-9, 53% of the loon deaths investigated in Vermont were caused by lead poisoning.
Build Responsibly	Any work in the lake such as dock or wall building may require a Shoreline Encroachment permit. (Call 802-241-3777.)	Artificial structures alter the natural functions of a shoreline, by removing vegetation and altering the natural lake bottom. Also, improperly done work can cause excess turbidity in the water.
Be safe!	Learn about Vermont's boating safety laws (call 802-244-8727 for a booklet).	Make lakes safe and enjoyable for everyone!
Work Together	• Join the local lake or pond association, or start one. • Get involved in town policy and planning discussions; assist the planning commission with lake protection issues.	• Many lakes and ponds have associations dedicated to taking care of the lake. They are involved in projects such as water sampling, landowner education, boating safety and watershed management. • Town Select Boards, planning and conservation commissions are good allies for lake protection.

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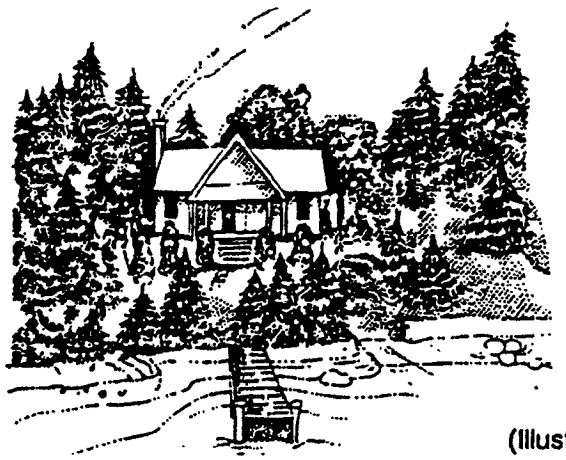

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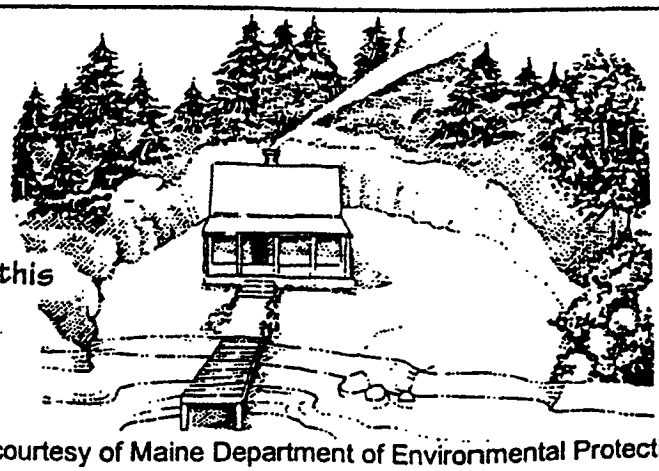


(Illustration courtesy of Maine Department of Environmental Protection)

Vermont Invasive Exotic Plant Fact Sheet

Eurasian Watermilfoil

Myriophyllum spicatum L.

Watermilfoil Family

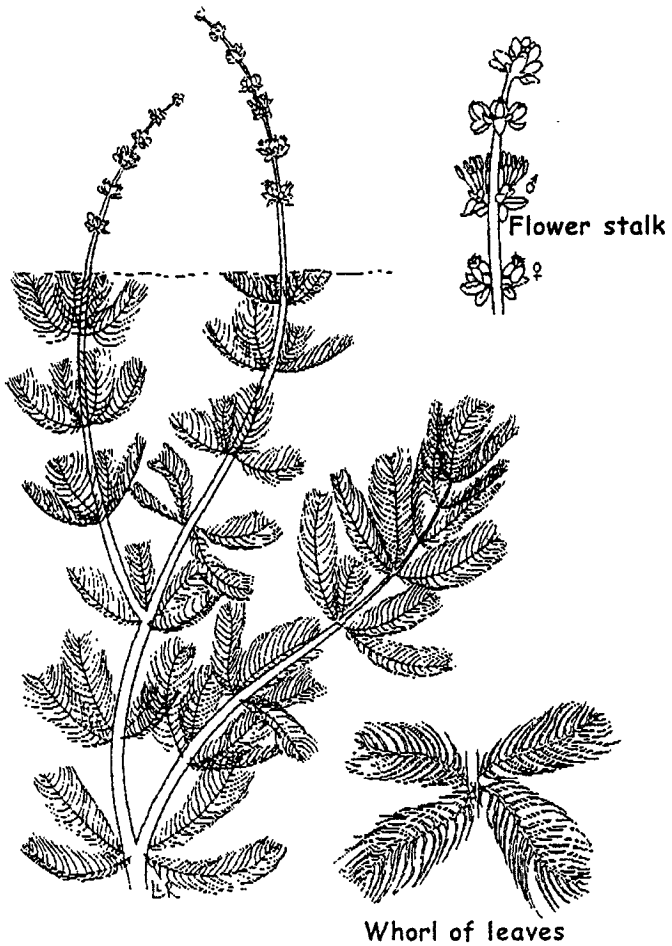
Vermont Class B Noxious Weed

Description: Eurasian watermilfoil is a submersed, perennial aquatic plant with leaves arranged in whorls of four around the stem. Each leaf is finely divided into many paired leaflets, giving the plant a delicate, feathery appearance. The plants are rooted in the bottom and usually branch heavily as they reach the water surface, forming a dense mat. The tops of Eurasian watermilfoil plants frequently have a reddish color. Erect flower spikes rise above the water surface. Flowers are small and are reddish in color. The spread of Eurasian watermilfoil can occur through seeds but is most frequently a result of vegetative fragmentation. Eurasian watermilfoil is similar in appearance to several species of native watermilfoils, but can be distinguished by having 11 or more leaflets on each side of the leaf midrib (natives have fewer leaflets).

Habitat: Eurasian watermilfoil can be found in lakes, ponds, reservoirs, rivers, canals, and drainage ditches. Eurasian watermilfoil grows along shallow shoreline areas as well as in deeper water, 25 feet (7.5 meters) deep or more. It is tolerant of a wide range of environmental conditions.

Threats: Eurasian watermilfoil is highly invasive and competes aggressively with native aquatic plant species, thereby reducing biodiversity. Dense milfoil infestations can severely impair swimming, boating, and fishing activities. When the plant grows in dense mats, water quality and fish abundance and distribution can also be affected.

Distribution: Eurasian watermilfoil is native to Europe and Asia. It was first introduced into North America in the mid 1940s. The first sighting of the plant was in a pond in Washington, D.C. Since then it has spread to at least 45 states and three Canadian provinces. The quick spread of Eurasian watermilfoil



(Aquatic plant line drawing is the copyright property of the University of Florida Center for Aquatic Plants (Gainesville). Used with permission.)

Distribution continued: across the country has been attributed mainly to boat traffic, where plant fragments have been transported accidentally from one site to another on motorboat propellers and trailers. The dumping of aquaria has also been the suspected source of some new populations. Eurasian watermilfoil infests over 57 lakes and several rivers throughout Vermont, including the Connecticut River.

This fact sheet is one in a series on invasive exotic plants in Vermont and is a cooperative project between the Departments of Environmental Conservation, Fish and Wildlife, and Forests, Parks and Recreation of the Vermont Agency of Natural Resources, and The Nature Conservancy of Vermont. Winter 2003

Vermont Invasive Exotic Plant Fact Sheet

Eurasian Watermilfoil
Watermilfoil Family *(Haloragaceae)*

Control: Eurasian watermilfoil is controlled through various mechanical, chemical, biological, and physical methods. Mechanical methods include harvesting, hydro-raking, diver-operated suction harvesting, and dredging. Some aquatic herbicides, such as fluridone, triclopyr, and 2,4-D can be effective. Biological methods include the use of the herbivorous Asian fish known as the grass carp and a milfoil-eating weevil (*Euhrychiopsis lecontei*) native to North America. **(Introduction of grass carp in Vermont is illegal because they consume other vegetation and create erosional and siltation problems.)** The use of the weevil is experimental at this time but it has shown promise. Other techniques used for milfoil control are overwinter drawdowns (lowering lake water levels to expose milfoil to drying and freezing), bottom barriers (mats anchored to the bottom that kill plants by blocking out sunlight), and hand-pulling.

* No person may use pesticides, biological controls, bottom barriers, structural controls or powered mechanical devices in waters of the state to control nuisance aquatic vegetation, insects or other aquatic life including lamprey unless that person has been issued a permit by the secretary of the Agency of Natural Resources.

References:

Couch, Richard, and E. Nelson. 1985. *Myriophyllum spicatum in North America.* In: Proceedings of the First International Symposium on Watermilfoil and Related Haloragaceae Species. Vancouver, British Columbia, Canada.

Crow, G.E. and C.B. Hellquist. 1983. *Aquatic Vascular Plants of New England: Part 6. Trapaceae, Haloragaceae, Hippuridaceae.* New Hampshire Agricultural Experiment Station, University of New Hampshire, Durham, New Hampshire. Station Bulletin 524.

For more information about Vermont's invasive exotic plant species or if you would like to know how you can help, please contact:

The Nature Conservancy of Vermont, 27 State Street, Montpelier, VT 05602
Tel: 802-229-4425

Vermont Department of Environmental Conservation, 103 S. Main St., Bldg. 10 North, Waterbury,VT 05671-0408 Tel. 802-241-3777

Vermont Department of Fish and Wildlife, 103 S. Main St., Bldg. 10 South, Waterbury, VT 05671-0501 Tel. 802-241-3715

Vermont Department of Forests, Parks and Recreation, 103 S. Main St., Bldg. 10 South, Waterbury, VT 05671-0601 Tel. 802-241-3678